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(54) PROCESS FOR PRODUCING A PLASTICS LAMINATE

(71) We, STANDARD OIL COMPANY, of 910 South Michigan Avenue, Chicago, Illinois, 60680, United States of America, a corporation organized and existing under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for producing a plastics laminate.

In the early stages of developing extruded polystyrene foam sheet it appeared that, if properties of high gloss and high strength could be imparted to one surface of the sheet, dishes and the like could be thermally formed and trimmed from the sheet having a desirable china-like surface. It was found that coating the polystyrene foam with a resinous polymeric material would provide the desired strength and gloss properties. The physical properties of the product of coating polystyrene foam sheet with resinous polymeric materials are superior to the properties of either the polystyrene foam sheet or the resinous polymeric material alone. The gloss, rigidity, abrasion resistance and cut resistance of extruded foam polystyrene sheet are substantially improved with a resinous polymeric material coating, and conversely, a resinous polymeric material film is substantially improved in its insulative properties, rigidity and toughness when combined with an extruded foam polystyrene, substrate in a product having a white appearance.

According to the present invention there is provided a process for producing a plastics laminate comprising the steps of continuously advancing a sheet of heat fusible foamed plastics material past an extruder die, continuously extruding a layer of molten resinous polymeric material from the die onto a surface of the sheet, the resinous polymeric material when contacting the sheet being at a temperature sufficient to fuse a thin surface layer of the sheet, and compressing the sheet and resinous polymeric material to form a laminate.

The process preferably includes heating the resinous material in an extruder, such extruder being any of those types in common use in the plastics industry, having a heating means an a compression means. Resinous polymeric material may thus be melted in an extruder whereupon it is forced out of the barrel and through a flat film die preferably under a pressure in the range of from 1,000 to 5,000 pounds per square inch. As used in the specification and claims the verb "to melt" means "to plasticize by heat until extrudable". The flat film die desirably has a gap or opening of from 2 to 100 thousandths of an inch and an effective width approximately equal to the width of the heat fusible plastics, e.g. polystyrene) foam sheet to be coated. The die can be provided with conventional heating means.

The molten resinous polymeric material is continuously extruded through the die and onto the heat fusible plastics (e.g. polystyrene) foam layer which should be moving past the die. The coated heat fusible plastics (e.g. polystyrene) foam is then compressed preferably between two rollers, a nip roller and a chill roller. The nip roller is preferably heated to between 100° and 200°F. and the chill roller is preferably cooled to between 40° and 80°F. The temperature of the rollers should be controlled so that the polymeric resin material does not cool so much that it cannot melt a thin layer of the foam polystyrene and fuse thereto. The clearance between these two rollers, which causes the coated polystyrene foam laminate to be compressed is commonly referred to as the nip. In the practice of this invention the nip pressure per linear inch must be adequate to press the coating into the foam substrate. Such a nip pres-

sure may be that generally sufficient to compress the coated foam sheet to about ½ its normal thickness. The foam, being resilient, regains a major part of its original thickness after being compressed. After compression the laminate is held in contact with the chill roller which cools it and which can also impart desirable surface characteristics to the polymeric resinous layer. For example, if a mirror surface is desired a highly polished chill roller should be used.

The polymeric resinous materials useful in practising this invention are preferably acrylonitrile-butadiene-styrene copolymers, polyvinylchloride, crystalline polystyrene, rubber modified polystyrene, acrylonitrile-polystyrene copolymer, polypropylene or polyethylene. The temperature of the polymer leaving the die should be about 450°F. since at this temperature it will remain hot long enough to melt a thin layer of the polystyrene foam sheet, thus enabling it to adhere thereto.

The laminate product of this invention can be used for panels in homes, buildings, truck trailers and mobile homes. It can be used for dishes and packaging containers. It can also be used as a material of construction for such things as refrigerators, ice chests and even toys and recreational equipment.

The process of the invention will be described in more detail with particular reference to the accompanying drawings in which:

Figure 1 is a schematic elevation of a coating machine having a horizontal extruder 13; and

Figure 2 is a schematic elevation of a coating machine having a vertical extruder 13a.

In Figure 1 the heat fusible foam sheet 1 travels from an unwind station 11 through a tension control 12 and onto a nip roller 14, which is a roller that forms a nip or compression means with a second roller. The heat fusible foam sheet 10 is then coated with a polymeric resinous material extruded through a flat film die 15 attached to extruder 13. The coated sheet 16 is then transferred to a chill roller 17 which is a cooled roller opposite the nip roller which forms a part of the compression means and also imparts desirable surface characteristics to the coating. The coated heat fusible foam sheet 16 is next transferred to a third roller 18 which diverts the pass of the sheet and enables it to extend around and thus remain in contact with the chill roller 17 for, for example, about one-half of its circumference. The coated side having been immediately coated does not contact the surface of the third roller 18. The three rollers referred to above are externally powered to impart motion to the heat fusible foam sheet 10. The coated sheet 16 is then passed through another tension control 19 and wound upon a rewind roll at the rewind station 20. The rewind roller at the rewind station 20 is also powered by an external power source to impart motion to the coated heat fusible foam sheet 16 to wind the finished product.

In Figure 2 the heat fusible foam sheet 10a travels from an unwind station 11a through a tension control 12a and onto a nip roller 14a, which is a roller that forms a nip or compression means with a second roller. The heat fusible foam sheet 10a is then coated with a polymeric resinous material extruded through a flat film die 15a attached to extruder 13a. The coated sheet is then transferred to a chill roller 17a which is a cooled roller opposite the nip roller which forms a part of the compression means and also imparts desirable surface characteristics to the coating. The coated heat fusible foam sheet 16a is next transferred to a third roller 18a which enables it to remain in contact with the chill roller 17a for about one-half of its circumference. The coated side having been immediately coated does not contact the surface of the third roller 18a. The three rollers referred to above are externally powered to impart motion to the heat fusible foam sheet 10a. The coated sheet 16a is then passed through another tension control 19a and wound upon a rewind roll at the rewind station 20a. The rewind roll at the rewind station 20a is also powered by an external power source to impart motion to the coated heat fusible foam sheet 16a to wind the finished product.

Preferably, the extruder has a barrel, a heating means and a compresison means. The compression means of the extruder is an auger contained inside the barrel having from 18 to 30 flights (revolutions of the helical inclined plane along the length of the barrel). The heating means is either an electric or oil heater positioned outside and along the barrel to create independently controlled heat zones inside the barrel. Some heat is also provided by working of the material in the auger compression means. The barrel temperature should be between 400° and 475°F., and preferably about 450°F., the barrel having an inside diameter of between 1 and 12½ inches. The polymeric resinous material can thus be extruded in a continuous operation.

It is preferred that extrusion be through a heated flat film die. The temperature of the die is held between 375° and 500°F. by either an electric or an oil heater. The pressure inside the die will generally fall in the range of 1,000 to 5,000 psi depending upon the polymeric resinous material used. The die pressure is preferably 1,500 psi. The gap (opening) in the die is approximately 2 to 100 thousandths of an inch, preferably 10 thousandths, with the width of

the die varying with the width of the polystyrene foam sheet to be coated.

For best results it is important that the molten resinous coating mtacrial contact the polystyrene foam sheet while it is on the nip roller. Contacting the two materials at this point ensures that the resinous polymeric material will contact the foam sheet while it is being held smooth and free from wrinkles. The product will then be free of wrinkles and surface imperfections. It has also been found that rotating the nip roller between 0 and 10% slower than the chill roller (based on the surface speed of the chill roller) and the third roller between 0 and 10% faster than the chill roller (based on the surface speed of the chill roller) results in a more smooth and uniform product. It has been found that about 2% variance in speed (based on the surface speed of the chill roller) is the optimum. Preferably, the surface speed of the chill roller is substantially equal to the speed of advancement of the sheet. In addition, the tension on the polystyrene foam sheet is controlled by two tension controls (shown in the figures). The preferred tension on the coated sheet coming off the rolls is between 2 and 20 pounds per linear inch.

The linear speed of the polystyrene foam sheet as it travels from the unwind station to the rewind station is dependent upon the thickness of the polymeric resinous material to be applied, the output of the polymeric resinous extruder and the capabilities of the unwind station and the rewind station (shown in the figures). Speeds can range from 100 to 2000 feet per minute depending upon these variables.

Various heat fusible foam sheets can serve as the substrate in the coating process of this invention. The following are examples of the more important foams which can be coated: polystyrene, styrene copolymers, polyethylene, polypropylene and polyvinylchloride. It should be noted, however, that polyethylene and polypropylene foam sheets are usually only effective as substrates when they are being coated with polyethylene and polypropylene respectively. Similarly, polyethylene and polypropylene are usually only effective as coating materials when polyethylene and polypropylene foam sheets are the respective substrates.

The compression of the polymeric resinous material onto the polystyrene foam sheet substrate, which is preferably of sufficient magnitude to press the resinous material into the sheet, may be effected without nip compression by increasing the linear tension of the foam substrate, thereby causing the polymeric material to be compressed slightly as it is wrapped between the nip roll and the foam substrate.

WHAT WE CLAIM IS:—

1. A process for producing a plastics laminate comprising the steps of continuously advancing a sheet of heat fusible foamed plastics material past an extruder die, continuously extruding a layer of molten resinous polymeric material from the die onto a surface of the sheet, the resinous polymeric material when contacting the sheet being at a temperature sufficient to fuse a thin surface layer of the sheet, and compressing the sheet and resinous polymeric material to form a laminate.

2. A process according to claim 1 in which compression is effected by passing the sheet between a nip roller and a chill roller, the path of the sheet is diverted by a third roller so that the sheet extends around a portion of the circumference of the chill roller and the layer of molten resinous material is extruded onto the surface of the sheet which contacts the chill roller.

3. A process according to claim 2 in which the surface speed of the chill roller is substantially equal to the speed of advancement of the sheet of foamed plastics material.

4. A process according to claim 2 or claim 3 in which the surface speed of the nip roller is from 0 to 10% slower than that of the chill roller and the surface speed of the third roller is from 0 to 10% faster than the of the chill roller.

5. A process for continuously coating a sheet of heat fusible foam sheet comprising (1) melt a resinous polymeric material; (2) extruding said resinous material through a flat film die; (3) contacting the sheet and the resinous polymeric material; the resinous polymeric material being at a temperature sufficient to fuse a thin surface layer of the sheet; and (4) compressing said contacted sheet and resinous polymeric material in compression roller means comprising (i) a nip roller, (ii) a chill roller and (iii) a third roller, said compression roller means and rewind roller means imparting motion to the heat fusible foam sheet as it travels through said compression roller means and subsequently onto the rewind roller.

6. A process according to claim 5 in which the contacting of the resinous polymeric material and the heat fusible foam sheet is effected subsequent to said heat fusible foam sheet passing into the roller means wherein a laminate is formed and the nip roller is operated up to 10% slower than the chill roller, based on the surface speed of the chill roller and the third roller is operated up to 10% faster than the chill roller, based on the surface speed of the chill roller.

7. A process according to claim 5 in which the heat fusible sheet and the resinous polymeric material are compressed together

by simultaneous contact on either side by the roller means. the roller means and the rewind roller being externally powered.

8. A process according to claim 7 in which the foam sheet is held flat and smooth on the surface of the nip roller before it is compressed by said roller means and said resinous polymeric material is fused into the sheet.

9. A process according to any one of claims 2 to 8 wherein the nip roller is rotated about 2% slower than the chill roller, based upon the surface speed of the chill roller. and the third roller is rotated about 2% faster than the chill roller, based upon the surface speed of the chill roller.

10. A process according to any preceding claim wherein the heat fusible foam sheet is polystyrene. styrene copolymers, or polyvinylchloride.

11. A process according to any preceding claim wherein the resinous polymeric material is acrylonitrile-butadiene-styrene copolymer. polyvinylchloride, crystalline polystyrene, rubber modified polystyrene or acrylonitrile-styrene copolymer.

12. A process according to any preceding claim wherein the resinous polymeric material is extruded at a temperature of about 450°F.

13. A process according to any preceding claim wherein the nip roller is held at a temperature between 100° and 200°F.

14. A process according to any preceding claim wherein the polymeric resinous material is extruded through a flat film die under pressure of between 1,000 and 5,000 pounds per square inch.

15. A process according to claim 14 wherein the pressure is about 1,500 pounds per square inch.

16. A process according to any preceding claim wherein the heat fusible foam sheet is polyethylene and the resinous polymeric material is polyethylene.

17. A process according to any one of claims 1 to 15 wherein the heat fusible foam sheet is polypropylene and the resinous polymeric material is polypropylene.

18. A process according to any preceding claim wherein the chill roller imparts desirable surface characteristics to the coated side.

19. A process according to any preceding claim wherein the chill roller is maintained at a temperature between 40° and 80°F.

20. A process according to any preceding claim wherein the linear speed of the heat fusible foam sheet is from 100 to 2000 feet per minute.

21. A process according to any preceding claim wherein the tension on the sheet is between 2 and 20 pounds per linear inch.

22. A process according to any preceding claim in which the resinous polymeric material and the heat fusible foam sheet are compressed sufficiently to press the resinous polymeric material into the heat fusible foam sheet.

23. A process for producing a plastics laminate according to claim 1 and substantially as hereinbefore described.

24. A process for producing a plastic laminate according to claim 1 and substantially as illustrated in either of Figures 1 and 2.

25. A plastics laminate whenever produced by a process according to any preceding claim.

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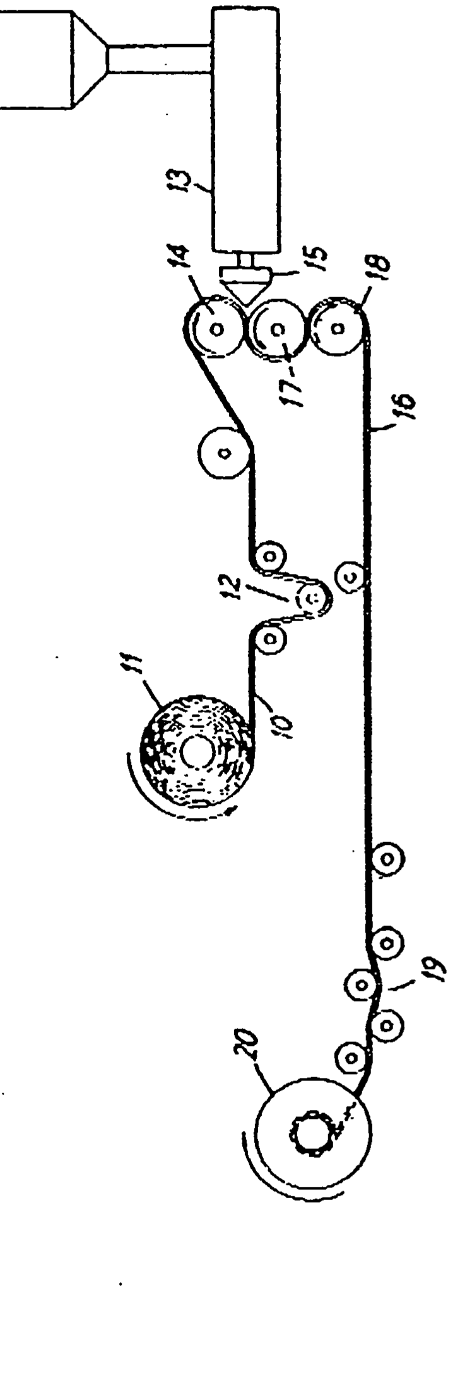

FIG. 1

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1346780 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

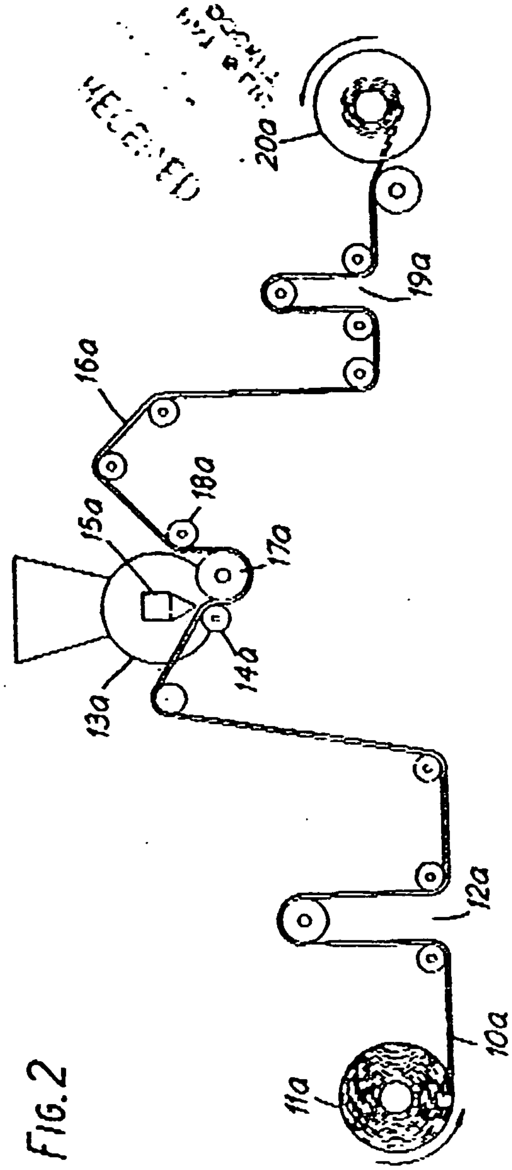

FIG.2

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